Dangerous Properties of Industrial Materials

Sixth Edition

N. IRVING SAX

Assisted by:
Benjamin Feiner/Joseph J. Fitzgerald/Thomas J. Haley/Elizabeth K. Weisburger

VNR VAN NOSTRAND REINHOLD COMPANY
NEW YORK CINCINNATI TORONTO LONDON MELBOURNE

KEY TO ABBREVIATIONS

(Refer to Introduction for Elaboration of Certain Definitions)

alc-alcohol
ALR-allergenic effects
AQTX-Aquatic Toxicity
asn-Aspergillus nidulans
BCM-blood clotting mechanism effects
bcs-Bacillus subtilis
BLD-blood effects
bmr-bone marrow
BPR-blood pressure effects
brd-bird (domestic or lab)
bwd-wild bird species
C-continuous
CARC-carcinogenic effects
cc-cubic centimeter
chd-child
ckn-chicken
CL-ceiling concentration
CNS-central nervous system effects
compds-compounds
crys-crystal
CUM-cumulative effects
CVS-cardiovascular effects
cyt-cytogenetic analysis
D-day
dck-duck
DDP-drug dependence effects
dec-decomposes
DEF-definition
dlt-dominant lethal test
dmg-Drosophila melanogaster
dnd-DNA damage
dnr-DNA repair
dns-unscheduled DNA synthesis
dom-domestic
DOT-Department of Transportation
dpo-Drosophila pseudo-obscura
emb-embryo
EPA-Environmental Protection Agency
esc-Escherichia coli
ETA-equivocal tumorigenic agent
eye-administration into eye (irritant)
EYE-eye effects (systemic)
fbr-fibroblast
frg-frog
g, gm-gram
GIT-gastrointestinal tract effects
GLN-glandular effects
gpg-guinea pig
grb-gerbil
H, hr-hour
ham-hamster
hla-HeLa cell
hma-host-mediated assay
hmn-human
I-intermittent
ial-intraaural
IARC-International Agency for Research on Cancer
iat-intraarterial
ice-intracerebral
icv-intracervical
idr-intradermal
idu-intraduodenal
ihl-inhalation
imm-immersion
imp-implant
ims-intramuscular
inf-infant
ipc-intraplacental
ipl-intrapleural
ipr-intraperitoneal
IRDS-primary irritation dose
irn-intrarenal
IRR-irritant effects (systemic)
isp-intraspinal
itr-intratracheal
ivg-intravaginal
ivn-intravenous
kg-kilogram (one thousand grams)
klp-Klebsiella pneumoniae
L-liter
LC50-lethal concentration 50 percent kill
LCLo-lowest published lethal concentration
LD50-lethal dose 50 percent kill
LDLo-lowest published lethal dose
leu-leukocyte
lel-low explosive limit
uel-upper explosive limit
lng-lung
lvr-liver
lym-lymphocyte
M-minute(s)
M3, m3-cubic meter(s)
mam-mammal (species unspecified)
mem-membrane
u, μ-micron
mg-milligram (one thousandth of a gram;10-3 gram)
misc-miscible
mky-monkey
ml-milliliter
MLD-mild irritation effects
mm-millimeters
mma-microsomal mutagenicity assay
MMI-mucous membrane effects
mmo-mutation in microorganisms
mmol-millimole
mmr-mammary gland
mnt-micronucleus test
MOD-moderate irritation effects
mol-mole
mppcf-million particles per cubic foot
mrc-gene conversion and mitotic recombination
msc-mutation in somatic mammalian cells

MSK-musculo-skeletal effects
MTDS-mutation dose
MTH-mouth effects
mul-multiple routes
mumem-mucous membrane
mus-mouse
MUT-mutagen
NEO-neoplastic effects
ng-nanogram (one billionth of a gram;10-9 gram)
nmol-nanomole
nsc-Neurospora crassa
nse-non-standard exposure
NTP-National Toxicology Program
OBS-obsolete
ocu-ocular
open-open irritation test
orl-oral
OSHA-Occupational Safety and Health Administration
otr-oncogenic transformation
ovr-ovary
par-parenteral
pg-picogram (one trillionth of a gram;10-12 gram)
pgn-pigeon
Pk-peak concentration
pmol-picomole
PNS-peripheral nervous system effects
ppb-parts per billion (v/v)
pph-parts per hundred (v/v) (percent)
ppm-parts per million (v/v)
ppt-parts per trillion (v/v)
preg-pregnant
PSY-psychotropic effects
PUL-pulmonary system effects
qal-quail
RBC-red blood cell effects
rbt-rabbit
rec-rectal
REGS-standards and regulations
rns-rinsed with water
S, sec.-second(s)
sat-Salmonella typhimurium
sce-sister chromatid exchange
SCP-Standards Completion Program
scu-subcutaneous
SEV-severe irritation effects
skn-administration onto skin
SKN-skin effects (systemic)
sl-slightly
sln-sex chromosome loss and nondisjunction
slt-specific locus test
smc-Saccharomyces cerevisiae
sol-soluble
spm-sperm morphology
spont-spontaneous
sql-squirrel
srm-Serratia marcescens
ssp-Schizosaccharomyces pombe
SYS-systemic effects
TC-toxic concentration
TCLo-lowest published toxic concentration
TD-toxic dose
TDLo-lowest published toxic dose
TER-teratogenic effects
TFX-toxic effects
THR-Toxic hazard review
TLV-Threshold Limit Value
tod-toad
tox-toxic, toxicity
trk-turkey
trn-heritable translocation test
TWA-time weighted average
TXDS-toxic dose
μg, ug-microgram (one millionth of a gram;10-6 gram)
umol-micromole
U, unk-unreported, unknown
UNS-toxic effects unspecified in source
W-week
WBC-white blood cell effects
wmn-woman
Y-year
%-percent

Introduction

The list of substances includes drugs, food additives, pre servatives, ores, pesticides, dyes, detergents, lubricants, soaps, plastics, extracts from plant and animal sources, plants and animals which are toxic by contact or consumption, and industrial intermediates and waste products from production processes. Some of the information refers to materials whose composition is not perfectly known. The chemical substances included are assumed to exhibit the reported toxic effect in their pure state unless otherwise noted. However, even in the case of a supposedly "pure" substance, there is usually some degree of uncertainty as to its exact composition and the impurities which may be present. This possibility must be considered in attempting to interpret the data presented since the toxic effects observed could in some cases be caused by a contaminant.

Excluded from our list are tradename products representing compounded or formulated proprietary mixtures available as commercial products. These exclusions are necessary because of difficulties in assessing the contribution of each component of a mixture to that substance's toxicity and because a product's formulation is often changed by varying the components, their concentration, or the purity of the ingredients. Commercial product tradenames are included, however, when they represent a single active chemical entity or a well-defined mixture of relatively constant composition. Radioactive substances are included but the effect reported is the chemically produced effect rather than the radiation effect.

Each substance prime name is identified by a unique nine-position RTECS accession number (two letters and seven numerals) which varies directly with the alphabetic sequence of the name, so that toluene, for example, has a higher number than benzene. Each synonym is cross-referenced to its appropriate prime name accession number. The accession number is simply an identifier assigned alphabetically to each substance.

For each prime name accession number the following data are provided when available: the substance prime name and synonyms; a description of the substance (where necessary); CAS number; molecular formula; molecular weight; mutation, primary irritation, and toxic dose data; and citations to aquatic toxicity ratings, IARC reviews, ACGIH Threshold Limit Values, toxicological reviews, existing Federal standards, the NIOSH criteria document program for recommended standards, the NTP Carcinogenesis Testing Program, and the EPA TSCA inventory. Each data line and citation is referenced by CODEN to the source from which the information was abstracted. A complete list of CODEN abbreviations and their respective titles are listed. A complete list of standard abbreviations is given.

1. *Substance Prime Name.* The prime name of each substance is derived from the nomenclature used by the American Chemical Society's Chemical Abstracts Service (CAS) in the 9th Collective Index (9 CI) of Chemical Abstracts.

2. The Chemical Abstracts Service Registry Number ("CAS") is a numeric designation assigned by the American Chemical Society's Chemical Abstracts Service and uniquely identifies a specific chemical compound. This entry allows one to conclusively identify a substance regardless of the name or naming system used.

3. Molecular weight (mw) is calculated from the molecular formula using standard elemental molecular weights (carbon = 12.01).

4. Molecular formula (mf) designates the elemental composition of the substance and is structured according to the Hill System (see *Journal of the American Chemical Society,* 22(8): 478-494, 1900) in which carbon and hydrogen (if present) are listed first, followed by the other elemental symbols in alphabetical order. The formula for compounds that do not contain carbon are ordered strictly alphabetically by element symbol. Compounds such as salts or those containing waters of hydration have molecular formulas incorporating the CAS dot-disconnect convention, in which the components are listed individually and separated by a period. The individual components of the formula are generally given in order of decreasing carbon atom count, and the component ratios given. A lower case "x" indicates that the ratio is unknown. A lower case "n" indicates a repeating, polymer-like struc-

ture. The formula is obtained from one of the cited references or a chemical reference text, or derived from the name of the substance.

5. Synonyms ("SYN") for the substance prime name are listed alphabetically. Synonyms include other chemical names, common or generic names, foreign names (with the language in parentheses), or codes. Some synonyms consist in whole or in part of registered trademarks. These trademarks are not identified as such.

The reader is cautioned that some synonyms, particularly common names, may be ambiguous and refer to more than one substance.

6. *Mutation Data.* Each mutation data line includes, in sequence, the mutation test system utilized, the species of the tested organism (and where applicable, the route of administration or cell type), the exposure concentration or dose, and the reference from which the information was extracted.

A mutation is defined as any heritable change in genetic material. Unlike irritation and toxic dose data which report the results of whole animal studies, muation data also include studies on lower organisms such as bacteria, molds, yeasts, and insects, as well as in vitro mammalian cell cultures. Studies of plant mutagenesis are not now included. No attempt is made to evaluate the significance of the data or to rate the relative potency of the compound as a mutagenic risk to man.

Each element of the mutation data line is discussed below.

Mutation Test System. A number of test systems are used to detect genetic alterations caused by chemical substances. Additional ones may be added as they are reported in the literature. Each test system is identified by the 3-letter code shown in parentheses. For additional information about mutation tests, the reader may wish to consult the *Handbook of Mutagenicity Test Procedures,* edited by B. J. Kilbey, M. Legator, W. Nichols, and C. Ramel (Amsterdam: Elsevier Scientific Publishing Company/North-Holland Biomedical Press, 1977).

(1) Mutation in Microorganisms (mmo)—System utilizes the detection of heritable genetic alterations in microorganisms which have been exposed directly to the chemical substance.

(2) Microsomal Mutagenicity Assay (mma)—System utilizes an in vitro technique which allows enzymatic activation of promutagens in the presence of an indicator organism in which induced mutation frequencies are determined.

(3) Micronucleus Test (mnt)—System utilizes the fact that chromosomes or chromosome fragments may not be incorporated into one or the other of the daughter nuclei during cell division.

(4) Specific Locus Test (slt)—System utilizes a method for detecting and measuring rates of mutation at any or all of several recessive loci.

(5) DNA Damage (dnd)—System detects the damage to DNA strands including strand breaks, crosslinks, and other abnormalities.

(6) DNA Repair (dnr)—System utilizes methods of monitoring DNA repair as a function of induced genetic damage.

(7) Unscheduled DNA Synthesis (dns)—System detects the synthesis of DNA during usually non-synthetic phases.

(8) Gene Conversion and Mitotic Recombination (mrc)—System utilizes unequal recovery of genetic markers in the region of the exchange during genetic recombination.

(9) Cytogenetic Analysis (cyt)—System utilizes cultured cells or cell lines to assay for chromosomal aberrations following the administration of chemical substances.

(10) Sister Chromatid Exchange (sce)—System detects the interchange of DNA in cytological preparations of metaphase chromosomes between replication products at apparently homologous loci.

(11) Sex Chromosome Loss and Nondisjunction (sln)—System measures the nonseparation of homologous chromosomes at meiosis and mitosis.

(12) Dominant Lethal Test (dlt)—A dominant lethal is a genetic change in a gamete that kills the zygote produced by that gamete. In mammals, the dominant lethal test measures the reduction of litter size. In insects, it measures the number of unhatched eggs.

(13) Mutation in Mammalian Somatic Cells (msc)—System utilizes the induction and isolation of mutants in cultured mammalian cells by identification of the gene change.

(14) Host-Mediated Assay (hma)—System uses two separate species, generally mammalian and bacterial, to detect heritable genetic alteration caused by metabolic conversion of chemical substances administered to host mammalian species in the bacterial indicator species.

(15) Sperm Morphology (spm)—System measures the departure from normal in the appearance of sperm.

(16) Heritable Translocation Test (trn)—Test measures the transmissibility of induced translocations to subsequent generations. In mammals, the test uses sterility and reduced fertility in the progeny of the treated parent. In addition, cytological analysis of the F1 progeny or subsequent progeny of the treated parent is carried out to prove the existence of the induced translocation. In Drosophila, heritable translocations are detected genetically using easily distinguishable phenotypic markers, and these translocations can be verified with cytogenetic techniques.

(17) Oncogenic Transformation (otr)—System utilizes morphological criteria to detect cytological differences between normal and transformed tumorigenic cells.

Those test species that are peculiar to mutation data are designated by the 3-letter codes shown below. Other species are listed in Table 2.

	Code	Species
Bacteria:	bcs	Bacillus subtilis
	esc	Escherichia coli
	klp	Klebsiella pneumoniae
	sat	Salmonella typhimurium
	srm	Serratia marcescens
Molds:	asn	Aspergillus nidulans
	nsc	Neurospora crassa
Yeasts:	smc	Saccharomyces cerevisiae
	ssp	Schizosaccharomyces pombe
Insects:	dmg	Drosophila melanogaster
	dpo	Drosophila pseudo-obscura

If the test organism is a cell type from a mammalian species (see Table 2), the parent mammalian species is reported, followed by a colon and the cell type designation. For example, human leukocytes are coded "hmn:leu." The various cell types currently cited in the Registry are listed below.

Designation	Cell Type
bmr	bone marrow
emb	embryo
fbr	fibroblast
hla	HeLa cell
leu	leukocyte
lng	lung
lvr	liver
lym	lymphocyte
mmr	mammary gland
ovr	ovary
tes	testis

In the case of host-mediated assays, both the host organism and the indicator organism are given as follows: host organism/indicator organism, e.g., "ham/sat" for a test in which hamsters were exposed to the test chemical and S. typhimurium was used as the indicator organism.

For in vivo mutagenic studies, the route of administration is specified following the species designation, e.g., "mus-orl" for oral administration to mice. See Table 1 for a complete list of routes cited. The route of administration is not specified for in vitro data.

Units of Exposure. The lowest dose producing a positive effect is cited. The author's calculations are used to determine the lowest dose at which a positive effect was observed. If the author fails to state the lowest effective dose, the Fisher's Exact Test is applied to the data. A positive effect is taken at the 0.05 level. Ideally, the dose should be reported in universally accepted toxicological units such as milligrams of test chemical per kilogram of test animal body weight. While this is possible in cases where the actual intake of the chemical by an organism of known weight is reported, it is not possible in many systems using insect and bacterial species. In cases where a dose is reported or where the amount can be converted to a dose unit, it is normally listed as milligrams per kilogram (mg/kg). However, micrograms (ug), nanograms (ng), or picograms (pg) per kilogram may also be used for convenience of presentation. Concentrations of gaseous substances in air are listed as parts per hundred (pph), per million (ppm), per billion (ppb), or per trillion (ppt).

Test systems using microbial organisms traditionally report exposure data as an amount of chemical per liter (L) or amount per plate, well, or disc. The amount may be on a weight (gm, mg, ug, ng, or pg) or molar (millimole (mmol), micromole (umol), nanomole (nmol), or picomole (pmol)) basis. These units describe the exposure concentration rather than the dose actually taken up by the test species. Insufficient data currently exist to permit the development of dose amounts from this information. In such cases, therefore, the substance concentration units used by the author are reported.

Since the exposure values reported in host-mediated assays are the doses delivered to the host organism, no attempt is made to estimate the exposure concentration to the indicator organism. The exposure values cited for host-mediated assay data are in units of milligrams (or other appropriate unit of weight) of substance administered per kilogram of host body weight.

7. Skin and Eye Irritation Data. Each irritation data line includes, in sequence, the tissue tested (skin or eye); the species of animal tested; the total dose and where applicable, the duration of exposure; for skin tests only, whether open or occlusive; an interpretation of the irritation response severity when noted by the author; and the reference from which the information was extracted. Only positive irritation test results are included.

Substances that are applied topically to the skin or to the mucous membranes can elicit either (a) systemic effects of an acute or chronic nature or (b) local effects, more properly termed "primary irritation." A primary irritant is a substance that, if present in sufficient quantity for a sufficient period of time, will produce a non-allergic, inflammatory reaction of the skin or of the mucous membrane at the site of contact. Primary irritants are further limited by the editors to those substances that are not corrosive. Hence, concentrated sulfuric acid is not classified as a primary irritant.

Primary Skin Irritation. In experimental animals, a primary skin irritant is defined as a chemical substance that produces an irritant response on first exposure in a majority of the test subjects. However, in some instances compounds act more subtly and require either repeated contact or special environmental conditions (humidity, temperature, occlusion, etc.) to produce a response.

TABLE 1. Routes of Administration to, or Exposure of, Animal Species to Toxic Substances

Route	Abbreviation	Definition
Eyes	eye	Administration directly onto the surface of the eye. Used exclusively for primary irritation data. See Ocular
Intraarterial	iat	Administration into the artery
Intraaural	ial	Administration into the ear
Intracerebral	ice	Administration into the cerebrum
Intracervical	icv	Administration into the cervix
Intradermal	idr	Administration within the dermis by hypodermic needle
Intraduodenal	idu	Administration into the duodenum
Inhalation	ihl	Inhalation in chamber, by cannulation, or through mask
Implant	imp	Placed surgically within the body—location described in reference
Intramuscular	ims	Administration into the muscle by hypodermic needle
Intraplacental	ipc	Administration into the placenta
Intrapleural	ipl	Administration into the pleural cavity by hypodermic needle
Intraperitoneal	ipr	Administration into the peritoneal cavity
Intrarenal	irn	Administration into the kidney
Intraspinal	isp	Administration into the spinal canal
Intratracheal	itr	Administration into the trachea
Intravaginal	ivg	Administration into the vagina
Intravenous	ivn	Administration directly into the vein by hypodermic needle
Multiple	mul	Administration into a single animal by more than one route
Ocular	ocu	Administration directly onto the surface of the eye or into the conjunctival sac. Used exclusively for systemic toxicity data
Oral	orl	Per os, intragastric, feeding, or introduction with drinking water
Parenteral	par	Administration into the body through the skin. Reference cited is not specific concerning the route used. Could be ipr, scu, ivn, ipl, ims, irn, or ice
Rectal	rec	Administration into the rectum or colon in the form of enema or suppository
Skin	skn	Application directly onto the skin, either intact or abraded. Used for both systemic toxicity and primary irritant effects
Subcutaneous	scu	Administration under the skin
Unreported	unk	Dose, but not route, is specified in the reference

The most standard animal irritation test is the Draize procedure (*Journal of Pharmacology and Experimental Therapeutics*, 82: 377-419, 1944). This procedure has been modified and adopted as a regulatory test by the Consumer Product Safety Commission (CPSC) in 16 CFR 1500.41 (formerly 21 CFR 191.11). In this test a known amount (0.5 ml of a liquid or 0.5 gm of a solid or semi-solid) of the test substance is introduced under a one square inch gauze patch. The patch is applied to the skin (clipped free of hair) of twelve albino rabbits. Six rabbits are tested with intact skin and six with abraded skin. The abrasions are minor incisions made through the stratum corneum, but are not sufficiently deep to disturb the dermis or to produce bleeding. The patch is secured in place with adhesive tape, and the entire trunk of the animal is wrapped with an impervious material, such as rubberized cloth, for a 24-hour period. The animal is immobilized during exposure. After 24 hours the patches are removed and the resulting reaction evaluated for erythema, eschar, and edema formation. The reaction is again scored at the end of 72 hours (48 hours after the initial reading), and the two readings are averaged. A substance producing any degree of positive reaction is cited as an irritant.

As the modified Draize procedure described above has become the standard test specified by the U.S. government, nearly all of the primary skin irritation data either strictly adheres to the test protocol or involves only simple modifications to it. When test procedures other than those described above are reported in the literature, appropriate codes are included in the data line to indicate those deviations.

The most common modification is the lack of occlusion of the test patch, so that the treated area is left open to the atmosphere. In such cases the notation "open" appears in the irritation data line. Another frequent modification involves whole arm or whole body immersion in the test substance or, more commonly, in a dilute aqueous solution of the test substance. This type of test is often conducted on soap and detergent solutions. Immersion data are identified by the abbreviation "imm" in the data line.

The dose reported is based first on the lowest dose producing an irritant effect and second on the latest study published. The dose is expressed as follows:

(1) Single application by the modified Draize procedure is indicated by only a dose amount. If no exposure time is given, then the data are for the standard 72-hour test. For test times other than 72 hours, the dose data is given in mg (or an appropriate unit)/duration of exposure, e.g., 10 mg/24H.

(2) Multiple applications involve administration of the dose in divided portions applied periodically. The total dose of test substance is expressed in mg (or an appropriate unit)/duration of exposure, with the symbol "I" indicating intermittent exposure, e.g., 5 mg/6D-I.

The method of testing substances for primary skin irritation given in the Code of Federal Regulations does not include an interpretation of the response. However, some authors do include a subjective rating of the irritation observed. If such a severity rating is given, it is included in the data line as mild ("MLD"), moderate ("MOD"), or severe ("SEV"). The Draize procedure employs a rating scheme which is included here for informational purposes only, since other researchers may not categorize irritation response in this manner.

Category	Code	Skin Reaction
Mild	MLD	Well defined erythema and slight edema (edges of area well defined by definite raising)
Moderate	MOD	Moderate to severe erythema and moderate edema (area raised approximately 1 mm)
Severe	SEV	Severe erythema (beet redness) to slight eschar formation (injuries in depth) and severe edema (raised more than 1 mm and extending beyond area of exposure)

Primary Eye Irritation. In experimental animals, a primary eye irritant is defined as a chemical substance that produces an irritant response in the test subject on first exposure. Eye irritation study procedures developed by Draize have been modified and adopted as a regulatory test by CPSC in 16 CFR 1500.42. In this procedure, a known amount of the test material (0.1 ml of a liquid or 100 mg of a solid or paste) is placed in one eye of each of six albino rabbits; the other eye remains untreated, serving as a control. The eyes are not washed after instillation and are examined at 24, 48, and 72 hours for ocular reaction. After the recording of ocular reaction at 24 hours, any or all eyes may be further examined following the application of fluorescein. Any or all eyes may also be washed with a sodium chloride solution (U.S.P. or equivalent) after the 24-hour reaction has been recorded.

A test is scored positive if any of the following effects are observed: (1) ulceration (besides fine stippling); (2) opacity of the cornea (other than slight dulling of normal luster); (3) inflammation of the iris (other than a slight deepening of the rugae or circumcorneal injection of the blood vessel); (4) swelling of the conjunctiva (excluding the cornea and iris) with eversion of the eyelid; or (5) a diffuse crimson-red color with individual vessels not clearly identifiable. A substance is an eye irritant if four of six rabbits score positive. It is considered a nonirritant if none or only one of six animals exhibits irritation. If intermediate results are obtained, the test is performed again. For the purpose of RTECS, substances producing any degree of irritation in the eye are identified as irritants. When an author has designated a substance as either a mild, moderate, or severe eye irritant, this designation is also reported.

The dose reported is based first on the lowest dose producing an irritant effect and second on the latest study published. Single and multiple applications are indicated as described above under "Primary Skin Irritation." Test times other than 72 hours are noted in the dose. All eye irritant test exposures are assumed to be continuous, unless the reference states that the eyes were washed after instillation. In this case, the notation "rns" (rinsed) is included in the data line.

Species Exposed. Since Draize procedures for determining both skin and eye irritation specify rabbits as the test species, most of the animal irritation data are for rabbits, although any of the species listed in Table II may be used. We endeavor to include as much human data as possible, since this information is directly applicable to occupational exposure. Much of this data comes from studies conducted on volunteers (such as for cosmetic or soap ingredients) or from persons accidentally exposed. When an accidental exposure, such as a spill, is cited, the data line includes the abbreviation "nse" (non-standard exposure). In these cases it is often very difficult to determine the precise amount of the substance to which the individual was exposed. Therefore, for accidental exposures an estimate of the concentration or strength of the substance, rather than a total dose amount, is generally provided.

8. *Toxicity Data.* Each toxic dose data line includes, in sequence, the route of exposure; the species of animal

studied; the toxicity measure; the amount of substance per body weight or concentration per unit of air volume and, where applicable, the duration of exposure; a descriptive notation of the type of effect reported; and the reference from which the information was extracted. Only positive toxicity test results are cited in this section.

All toxic dose data appearing in the book are derived from reports of the toxic effects produced by individual substances. For human data, a toxic effect is defined as any reversible or irreversible noxious effect on the body, any benign or malignant tumor, any teratogenic effect, or any death that has been reported to have resulted from exposure to a substance via any route. For humans, a toxic effect is any effect that was reported in the source reference. There is no qualifying limitation on the duration of exposure or for the quantity or concentration of the substance, nor is there a qualifying limitation on the circumstances that resulted in the exposure. Regardless of the absurdity of the circumstances that were involved in a toxic exposure, it is assumed that the same circumstances could recur. For animal data, toxic effects are limited to the production of tumors, benign (neoplastigenesis) or malignant (carcinogenesis); the production of changes in the offspring resulting from action on the fetus directly (teratogenesis); and death. There is no limitation on either the duration of exposure or on the quantity or concentration of the dose of the substance reported to have caused these effects. Note that reports of in vivo mutagenic effects previously cited in this section are now included under mutation data (p. xii).

TABLE 2. Species
(With Assumptions for Toxic Dose Calculation from Non-Specific Data*)

Species	Abbrev.	Age	Weight	Consumption (Approx.) Food gm/day	Water ml/day	1 ppm in Food Equals, in mg/kg/D
Bird—any domestic or laboratory bird reported but not otherwise identified	brd		1 kg			
Bird—wild bird species	bwd		40 gm			
Cat, adult	cat		2 kg	100	100	0.05
Cattle, Horse	ctl		500 kg	10,000		0.02
Chicken, adult (male or female)	ckn	8 W	800 gm	140	200	0.175
Child	chd	1-13 Y	20 kg			
Dog, adult	dog	52 W	10 kg	250	500	0.025
Domestic animals—goat, sheep	dom		60 kg	2,400		0.04
Duck, adult (domestic)	dck	8 W	2,500 gm	250	500	0.1
Frog, adult	frg		33 gm			
Gerbil	grb		100 gm	5	5	0.05
Guinea pig, adult	gpg		500 gm	30	85	0.06
Hamster	ham	14 W	125 gm	15	10	0.12
Human	hmn	Adult	70 kg			
Infant	inf	0-1 Y	5 kg			
Mammal—species unspecified in reference	mam		200 gm			
Man	man	Adult	70 kg			
Monkey	mky	2.5 Y	5 kg	250	500	0.05
Mouse	mus	8 W	25 gm	3	5	0.12
Pig	pig		60 kg	2,400		0.041
Pigeon	pgn	8 W	500 gm			
Quail (laboratory)	qal		100 gm			
Rabbit, adult	rbt	12 W	2 kg	60	330	0.03
Rat, adult female	rat	14 W	200 gm	10	20	0.05
Rat, adult male	rat	14 W	250 gm	15	25	0.06
Rat, adult, sex unspecified	rat	14 W	200 gm	15	25	
Rat, weanling	rat	3 W	50 gm	15	25	0.3
Squirrel	sql		500 gm			
Toad	tod		100 gm			
Turkey	trk	18 W	5 kg			
Woman	wmn	Adult	50 kg			

* NOTE: Values given here are within reasonable limits usually found in the published literature and are selected to facilitate calculations for data from publications in which toxic dose information has not been presented for an individual animal of the study. See, for example, Association of Food and Drug Officials, *Quarterly Bulletin*, volume 18, page 66, 1954, and Guyton, *American Journal of Physiology*, volume 150, page 75, 1947. Data for lifetime exposure are calculated from the assumptions for adult animals for the entire period of exposure. For definitive dose data, the reader must review the referenced publication.

The report of the lowest total dose administered over the shortest time to produce the toxic effect was given preference, although some editorial license was taken so that additional references might be cited. No restrictions were placed on the amount of a substance producing death in an experimental animal nor on the time period over which the dose was given. By law, however, a toxic effect must be produced for the dose published. Therefore, terms suggesting that a toxic or lethal effect may exist at doses greater than those tried cannot be used.

Each element of the toxic dose data line is discussed below:

Route of Exposure or Administration. Although many exposures to substances in the industrial community occur via the respiratory tract or skin, most studies in the published literature report exposures of experimental animals in which the test substances were introduced primarily through the mouth by pills, in food, in drinking water, or by intubation directly into the stomach. The abbreviations and definitions of the various routes of exposure reported are found in Table 1.

Species Exposed. Since the effects of exposure of humans are of primary concern, we have indicated, when available, whether the results were observed in man, woman, child, or infant. If no such distinction was made in the reference, the abbreviation "hmn" (human) is used. However, the results of studies on rats or mice are the most frequently reported and hence provide the most useful data for comparative purposes. The species and abbreviations used in reporting toxic dose data are listed alphabetically in Table 2.

Description of Exposure. In order to better describe the administered dose reported in the literature, six abbreviations are used. These terms indicate whether the dose caused death (LD) or other toxic effects (TD) and whether it was administered as a lethal concentration (LC) or toxic concentration (TC) in the inhaled air. In general, the term "Lo" is used where the number of subjects studied was not a significant number from the population or the calculated percentage of subjects showing an effect was listed as 100. The definition of terms is as follows:

TDLo—Toxic Dose Low—the lowest dose of a substance introduced by any route, other than inhalation, over any given period of time and reported to produce any toxic effect in humans or to produce carcinogenic, neoplastigenic, or teratogenic effects in animals or humans.

TCLo—Toxic Concentration Low—the lowest concentration of a substance in air to which humans or animals have been exposed for any given period of time that has produced any toxic effect in humans or produced a carcinogenic, neoplastigenic, or teratogenic effect in animals or humans.

LDLo—Lethal Dose Low—the lowest dose (other than LD50) of a substance introduced by any route, other than inhalation, over any given period of time in one or more divided portions and reported to have caused death in humans or animals.

LD50—Lethal Dose Fifty—a calculated dose of a substance which is expected to cause the death of 50% of an entire defined experimental animal population. It is determined from the exposure to the substance by any route other than inhalation of a significant number from that population. Other lethal dose percentages, such as LD1, LD10, LD30, and LD99, may be published in the scientific literature for the specific purposes of the author. Such data would be published if these figures, in the absence of a calculated lethal dose (LD50), were the lowest found in the literature.

LCLo—Lethal Concentration Low—the lowest concentration of a substance in air, other than LC50, which has been reported to have caused death in humans or animals. The reported concentrations may be entered for periods of exposure which are less than 24 hours (acute) or greater than 24 hours (subacute and chronic).

LC50—Lethal Concentration Fifty—a calculated concentration of a substance in air, exposure to which for a specified length of time is expected to cause the death of 50% of an entire defined experimental animal population. It is determined from the exposure to the substance of a significant number from that population.

The following table summarizes the above information:

Category	Exposure Time	Route of Exposure	TOXIC EFFECTS Human	TOXIC EFFECTS Animal
TDLo	Acute or Chronic	All except Inhalation	Any Non-Lethal	CARC, NEO ETA, TER
TCLo	Acute or Chronic	Inhalation	Any Non-Lethal	CARC, NEO ETA, TER
LDLo	Acute or Chronic	All except Inhalation	Death	Death
LD50	Acute	All except Inhalation	Not Applicable	Death (Statistically Determined)
LCLo	Acute or Chronic	Inhalation	Death	Death
LC50	Acute	Inhalation	Not Applicable	Death (Statistically Determined)

Units of Dose Measurement. As in almost all experimental toxicology, the doses given are expressed in terms of the quantity administered per unit body weight, or quantity per skin surface area, or quantity per unit volume of the respired air. In addition, the duration of time over which the dose was administered is also listed, as needed. Dose amounts are generally expressed as milligrams (one thousandth of a gram) per kilogram (mg/kg). In some cases, because of dose size and its practical presentation in the file, grams per kilogram (gm/kg), micrograms (one millionth of a gram) per kilogram (ug/kg), or nanograms

(one billionth of a gram) per kilogram (ng/kg) are used. Volume measurements of dose were converted to weight units by appropriate calculations. Densities were obtained from standard reference texts. Where densities were not readily available, all liquids were assumed to have a density of one gram per milliliter. Twenty drops of liquid are assumed to be equal in volume to one milliliter.

All body weights have been converted to kilograms (kg) for uniformity. For those references in which the dose was reported to have been administered to an animal of unspecified weight or a given number of animals in a group (e.g., feeding studies) without weight data, the weights of the respective animal species were assumed to be those listed in Table 2 and the dose is listed on a per kilogram body weight basis. Assumptions for daily food and water intake are found in Table II to allow approximating doses for humans and species of experimental animals where the dose was originally reported as a concentration in food or water. The values presented are selections which are reasonable for the species and convenient for dose calculations.

Concentrations of a gaseous substance in air are generally listed as parts of vapor or gas per million parts of air by volume (ppm). However, parts per hundred (pph or per cent), parts per billion (ppb), or parts per trillion (ppt) may be used for convenience of presentation. If the substance is a solid or a liquid, the concentrations are listed preferably as milligrams per cubic meter (mg/m3) but may, as applicable, be listed as micrograms per cubic meter (ug/m3), nanograms per cubic meter (ng/m3), or picograms (one trillionth of a gram) per cubic meter (pg/m3) of air. For those cases in which other measurements of contaminants are used, such as the number of fibers or particles, the measurement is spelled out.

Where the duration of exposure is available, time is presented as minutes (M), hours (H), days (D), weeks (W), or years (Y). Additionally, continuous (C) indicates that the exposure was continuous over the time administered, such as ad libitum feeding studies or 24-hour, 7-day per week inhalation exposures. Intermittent (I) indicates that the dose was administered during discrete periods, such as daily, twice weekly, etc. In all cases, the total duration of exposure appears first after the kilogram body weight and slash, followed by descriptive data; e.g., 10 mg/kg/3W-I means ten milligrams per kilogram body weight administered over a period of three weeks, intermittently in a number of separate, discrete doses. This description is intended to provide the reader with enough information for an approximation of the experimental conditions, which can be further clarified by studying the reference cited.

Frequency of Exposure. Frequency of exposure to the test substance varies depending on the nature of the experiment. Frequency of exposure is given in the case of an inhalation experiment, for human exposures (where applicable), or where CARC, NEO, ETA, or TER is specified as the toxic effect.

Duration of Exposure. For assessment of tumorigenic effect, the testing period should be the life span of the animal, or until statistically valid calculations can be obtained regarding tumor incidence. In the toxic dose line, the total dose causing the tumorigenic effect is given. The duration of exposure is included to give an indication of the testing period during which the animal was exposed to this total dose. For multigenerational studies, the time during gestation when the substance was administered to the mother is also provided.

Notations Descriptive of the Toxicology. The toxic dose line thus far has indicated the route of entry, the species involved, the description of the dose, and the amount of the dose. The next entry found on this line when a toxic exposure (TD or TC) has been listed is "TFX" (Toxic Effect). Following "TFX" will be one of the notations found in Table 3. These notations indicate the organ system affected or special effects that the substance produced, e.g., TER = teratogenic effect. No attempt was made to be definitive in reporting these effects because such definition requires much detailed qualification and is beyond the scope of time. The selection of the dose was based first on the lowest dose producing an effect and second on the latest study published.

The importance attached to reports of the carcinogenic activity of substances necessitates a more detailed discussion of the criteria used to include this type of data. Tumorigenic citations are classified according to the reported results of the study only to aid the reader in selecting appropriate references for in-depth review and evaluation. The classification, ETA (equivocal tumorigenic agent), denotes those studies reporting uncertain, but seemingly positive, results. The criteria for the three classifications are listed below. As explained in the Introduction, these criteria are used to abstract the data in individual reports on a consistent basis and do not represent a comprehensive evaluation of a substance's tumorigenic potential to humans.

Because of the increasing concern with carcinogens in the occupational environment, we now cite multiple studies in which tumorigenic responses were reported. That is, for a given substance, a particular route-species combination may be cited more than once if the results of the multiple studies are coded TFX:CARC, NEO, or ETA. These multiple tumorigen entries have been cited simply with a toxicity measure of TD (toxic dose) or TC (toxic concentration).

The following 9 technical criteria are used to abstract the toxicological literature and classify studies that report positive tumorigenic responses. No attempts are made either to evaluate the various test procedures or correlate results from different experiments.

(1) A citation is coded "TFX:CARC" (carcinogenic)

TABLE 3. Notations Descriptive of the Toxicology

Abbreviation	Definition (not limited to effects listed)
ALR	Allergic systemic reaction such as might be experienced by individuals sensitized to penicillin.
BCM	Blood clotting mechanism effects—any effect which increases or decreases clotting time.
BLD	Blood effects—effect on all blood elements, electrolytes, pH, protein, oxygen carrying or releasing capacity.
BPR	Blood pressure effects—any effect which increases or decreases any aspect of blood pressure.
CAR	Carcinogenic effects—see paragraph 9g in text.
CNS	Central nervous system effects—includes effects such as headaches, tremor, drowsiness, convulsions, hypnosis, anesthesia.
COR	Corrosive effects—burns, desquamation.
CUM	Cumulative effects—where substance is retained by the body in greater quantities than is excreted, or the effect is increased in severity by repeated body insult.
CVS	Cardiovascular effects—such as an increase or decrease in the heart activity through effect on ventricle or auricle; fibrillation; constriction or dilation of the arterial or venous system.
DDP	Drug dependence effects—any indication of addiction or dependence.
ETA	Equivocal tumorigenic agent—see paragraph 9g in text.
EYE	Eye effects—irritation, diploplia, cataracts, eye ground, blindness by affecting the eye or the optic nerve.
GIT	Gastrointestinal tract effects—diarrhea, constipation, ulceration.
GLN	Glandular effects—any effect on the endocrine glandular system.
IRR	Irritant effects—any irritant effect on the skin, eye, or mucous membrane.
MLD	Mild irritation effects—used exclusively for primary irritation data.
MMI	Mucous membrane effects—irritation, hyperplasia, changes in ciliary activity.
MOD	Moderate irritation effects—used exclusively for primary irritation data.
MSK	Musculo-skeletal effects—such as osteoporosis, muscular degeneration.
NEO	Neoplastic effects—see paragraph 9g in text.
PNS	Peripheral nervous system effects.
PSY	Psychotropic effects—exerting an effect upon the mind.
PUL	Pulmonary system effects—effects on respiration and respiratory pathology.
RBC	Red blood cell effects—includes the several anemias.
SEV	Severe irritation effects—used exclusively for primary irritation data.
SKN	Skin effects—such as erythema, rash, sensitization of skin, petechial hemorrhage.
SYS	*Systemic effects—effects on the metabolic and excretory function of the liver* or kidneys.
TER	Teratogenic effects—nontransmissible changes produced in the offspring.
UNS	Unspecified effects—the toxic effects were unspecific in the reference.
WBC	White blood cell effects—effects on any of the cellular units other than erythrocytes, including any change in number or form.

when review of an article reveals that all of the following criteria are satisfied:

(a) A statistically significant increase in the incidence of tumors in the test animals. The statistical test is that used by the author. If no statistic is reported, a Fisher's Exact Test is applied with significance at the 0.05 level, unless the author makes a strong case for significance at some other level.

(b) A control group of animals is used and the treated and control animals are maintained under identical conditions.

(c) The sole experimental variable between the groups is the administration or non-administration of the test substance (see (9) below).

(d) The tumors consist of autonomous populations of cells of abnormal cytology capable of invading and destroying normal tissues, or the tumors metastasize as confirmed by histopathology.

(2) A citation is coded "TFX:NEO" (neoplastic) when review of an article reveals that all of the following criteria are satisfied:

(a) A statistically significant increase in the incidence of tumors in the test animals. The statistical test is that used by the author. If no statistic is reported, a Fisher's Exact Test is applied with significance at the 0.05 level, unless the author makes a strong case for significance at some other level.

(b) A control group of animals is used, and the treated

and control animals are maintained under identical conditions.

(c) The sole experimental variable between the groups is the administration or non-administration of the test substance (see (9) below).

(d) The tumors consist of cells that closely resemble the tissue of origin, that are not grossly abnormal cytologically, that may compress surrounding tissues, but that neither invade tissues nor metastasize; or

(e) The tumors produced cannot definitely be classified as either benign or malignant.

(3) A citation is coded "TFX:ETA" (equivocal tumorigenic agent) when some evidence of tumorigenic activity is presented, but one or more of the criteria listed in (1) or (2) above is lacking. Thus, a report with positive pathological findings, but with no mention of control animals, is coded "TFX:ETA."

(4) Since an author may make statements or conclusions based on a larger context than that of the particular data reported, papers in which the author's conclusions differ substantially from the evidence presented in the paper are subject to review by the RTECS Editorial Review Board.

(5) All doses except those for transplacental carcinogenesis are reported in RTECS in one of the following formats.

(a) For all routes of administration other than inhalation:

cumulative dose in mg (or appropriate unit)/kg/duration of administration.

Whenever the dose reported in the reference is not in the above units, conversion to this format is made based on the information given in paragraph 9d above. The total cumulative dose is derived from the lowest dose level that produces tumors in the test group.

(b) For inhalation experiments:

concentration in ppm (or mg/m3)/total duration of exposure.

The concentration refers to the lowest concentration that produces tumors.

(6) Transplacental carcinogenic doses are reported in one of the following formats.

(a) For all routes of administration other than inhalation:

cumulative dose in mg/kg/(time of administration during pregnancy).

The cumulative dose is derived from the lowest single dose that produces tumors in the offspring. The test chemical is administered to the mother.

(b) For inhalation experiments:

concentration in ppm (or mg/m3)/(time of exposure during pregnancy).

The concentration refers to the lowest concentration that produces tumors in the offspring. The mother is exposed to the test chemical.

(7) For the purposes of this listing, all test chemicals are reported as pure, unless otherwise stated by the author. This does not rule out the possibility that unknown impurities may have been present.

(8) A mixture of compounds whose test results satisfy the criteria in (1), (2), or (3) above is included if the composition of the mixture can be clearly defined.

(9) For tests involving promoters or initiators, a study is included if the following conditions are satisfied (in addition to the criteria in (1), (2), or (3) above):

(a) The test chemical is applied first, followed by an application of a standard promoter. A positive control group in which the test animals are subjected to the same standard promoter under identical conditions is maintained throughout the duration of the experiment. The data are not used if no mention of positive and negative control groups is made in the reference.

(b) A known carcinogen is first applied as an initiator, followed by application of the text chemical as a promoter. A positive control group in which the test animals are subjected to the same initiator under identical conditions is maintained throughout the duration of the experiment. The data are not used if no mention of positive and negative control groups is made in the reference.

9. Cited Reference. The final entry of the mutation, irritation, and toxic dose data lines is the reference from which the information was extracted. All references cited are publicly available. No governmental classified documents have been used for source information. All references have been given a unique six-letter CODEN character code (derived from the American Society for Testing and Materials *CODEN for Periodical Titles* and the CAS *Source Index*), which identifies periodicals, serial publications, and individual published works. For those references for which no CODEN was found, the corresponding six-letter code includes asterisks (*) in the last one or two positions following the first four or five letters of an acronym for the publication title. Following the CODEN designation (for most entries) is the number of the volume, followed by a comma; the page number of the first page of the article, followed by a comma; and a two-digit number, indicating the year of publication in this century. When the cited reference is a report, the report number is listed. Where contributors have provided information on their unpublished studies, the CODEN consists of the first three letters of the last name, the initials of the first and middle names, and a number sign (#). The date of the letter supplying the information is listed. All CODEN acronyms are listed in alphabetical order and defined in the Bibliographic References section.

10. Aquatic Toxicity Ratings ("AQTX") were extracted from *Water Quality Characteristics of Hazardous Materials* by Dr. Roy Hahn, Jr. and Paul Jensen, Texas

A&M University, College Station, Texas 77843, 1974. This publication grew out of an extensive literature survey on aquatic pollution. "TLm96" is defined as the concentration that will kill 50% of the exposed organisms within 96 hours. The bioassay may be conducted under static or continuous flow conditions. Because of the lack of test standardization and the wide variety of species investigated, ratings (ranges of toxicities), rather than a single toxic dose, are used to give an indication of the toxicity of substances to aquatic life.

11. Reviews. This section supplies additional information to enable the reader to make knowledgeable evaluations of potential chemical hazards. There are three types of reviews listed: (a) International Agency for Research on Cancer (IARC) monograph reviews, which are published by the United Nations World Health Organization (WHO); (b) Threshold Limit Values, which are recommended limits proposed by the American Conference of Governmental Industrial Hygienists (ACGIH); and (c) general toxicology review articles.

a. Cancer Reviews. In the U.N. International Agency for Research on Cancer (IARC) monographs, information on suspected environmental carcinogens is examined, and summaries of available data with appropriate references are presented. Included in these reviews are synonyms, physical and chemical properties, uses and occurrence, and biological data relevant to the evaluation of carcinogenic risk to humans. The 29 monographs in the series contain an evaluation of approximately 800 substances. Single copies of the individual monographs (specify volume number) can be ordered from WHO Publications Centre USA, 49 Sheridan Avenue, Albany, New York 12210, telephone (518) 436-9686.

The entry "CARCINOGENIC DETERMINATION" indicates that some carcinogenicity data pertaining to a compound has been reviewed by the IARC committee. This indicates whether the data pertain to humans or to animals and whether the results of the determination are positive, suspected, indefinite, negative, or no data.

This cancer review reflects only the conclusion of the IARC committee based on the data available for the committee's evaluation. Hence, for some substances there may be disagreement between the IARC determination and the tumorigenicity information in the toxicity data lines.

b. Threshold Limit Value (TLV). The TLV is an ACGIH-recommended time-weighted average concentration of a substance to which most workers can be exposed without adverse effect. The notation "(skin)" indicates that even though the air concentration may be below the limit value, significant additional exposure to the skin may be dangerous. The TLV's are taken from *Documentation of the Threshold Limit Values for Substances in Workroom Air* (fourth edition), Cincinnati: ACGIH, 1980.

c. Toxicology Reviews. The entry "TOXICOLOGY REVIEW" indicates that the cited review article has been located in the literature. Each review is identified by its CODEN. These articles discuss one or more facets of the toxicology of the substance or the general class to which the substance belongs. Most of these references do not contain specific dose values that can be cited as mutation, irritation, or toxicity data (see p. xx) because of the selection criteria. However, the reviews do provide useful information about the toxicity of the substance or group of related substances. The reader is cautioned that the scope of discussion varies greatly among the reviews. Some articles may contain a complete, detailed description of the toxicity of a substance; others may address only a particular aspect of the toxicity (e.g., effect of a substance on fetal development, or body fluid and tissue levels of a substance found under conditions of poisoning); and others may only list the substance in a general discussion of the toxicity of a class of compounds.

12. Standards and Regulations contains notations indicating that the substance is regulated by an agency of the United States Government. The heading of these lines is "STANDARDS AND REGULATIONS," followed either by "OSHA," "EPA," or "DOT." "OSHA" refers to standards promulgated under Section 6 of the Occupational Safety and Health Act of 1970. "EPA" refers to Worker Protection Standards for Agricultural Pesticides promulgated by the Environmental Protection Agency under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). "DOT" refers to substances regulated for shipment by the Department of Transportation. Because of frequent changes to and litigation of Federal regulations, it is recommended that the reader contact the applicable agency for information about the current standards for a particular substance. Omission of a substance or regulatory notation from the Registry does not imply any relief from regulatory responsibility.

OSHA air contaminant standards are noted with the entry "air" following "OSHA." "TWA" or "CL" refers to either time-weighted average or ceiling value, respectively. For some substances, TWA, CL, and Pk (peak) values are given in the standard. In those cases, all three are listed. Finally, some entries may be followed by the designation "(skin)." This designation indicates that the compound may be absorbed by the skin and, even though the air concentration may be below the standard, significant additional exposure through the skin may be possible.

The entry "(SCP)" following "OSHA" indicates that a draft technical standard has been developed for the substance under the joint NIOSH/OSHA Standards Completion Program. Upon promulgation by OSHA, this draft technical standard fulfills the requirements for a complete standard for the substance as required by Sections 6 and 8 of the Occupational Safety and Health Act (29 CFR 1910.1000). A draft technical standard includes

requirements for apprising employees of all hazards to which they are exposed, acceptable personal protective equipment, engineering control procedures, air sampling and analytical procedures, medical surveillance, and recordkeeping. The letter entry following SCP, for example "(SCP-A)," refers to a specific set of draft standards for a group of compounds that were prepared concurrently. Acceptable methods for sampling and analysis have been developed by NIOSH for many of the substances covered by a draft technical standard.

The information following the DOT notation for a substance has been obtained from the Department of Transportation. This notation indicates (a) the hazard class, (b) the label(s) required, and (c) the proper shipping name(s), as specified for transportation. Except for certain export and import shipments, no person may offer or accept a hazardous material, as defined by the Code of Federal Regulations, Title 49, for transportation in commerce within the United States unless that material is properly classed, described, packaged, marked, labeled, and in the condition for shipment as specified by 49 CFR, Parts 100 to 189. For transportation purposes, a hazardous material means a substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce and which has been so designated.

Specific definitions are given for each hazard class addressed in 49 CFR; however, DOT reserves the right to regulate or deregulate materials whether or not they meet these definitions. The basic hazard classes include compressed gases, flammables, oxidizers, corrosives, explosives, radioactive materials, and poisons. Although a material may be designated by only one hazard class, additional hazards may be indicated by adding labels or by using other means directed by DOT.

It is essential, therefore, to know the hazard class of a substance and to use the proper label. Generally, a material meeting the DOT definition of a poison must always be labeled as a poison, regardless of the other labeling requirements to ensure adherence to the prohibition against shipping poisons with foodstuffs.

Specific shipping names are designated for hazardous materials listed in 49 CFR. Because of the presence of many nontechnical names or the use of archaic names for some materials, it is necessary to identify the DOT shipping names. The approved DOT shipping names are included as synonyms of the prime names and are identified by the addition of "(DOT)" to the name.

Substances not specifically identified in 49 CFR and not appearing in the Registry are not necessarily exempt from DOT regulations. The Registry contains only those substances specifically identified in 49 CFR. Generic names or general descriptive names such as "insecticide, liquid" are not included in the Registry. Determination of the correct classification for transportation of materials not specifically identified in 49 CFR is the responsibility of the shipper.

13. Criteria Documents. This entry indicates that a NIOSH criteria document recommending a certain environmental (occupational) exposure has been published for this compound or for a class of compounds to which this substance belongs. Included are the title of the document and the recommended standard. The CODEN citation ("NTIS**") refers to the National Technical Information Service, U.S. Department of Commerce.

14. Status. This provides information on the activities of various governmental agencies regarding the substance. Status lines are currently listed for NTP, NIOSH, and EPA.

a. An NTP status entry indicates that the substance has been or is being tested by the National Toxicology Program (NTP) under its Carcinogenesis Testing Program. These entries were identified as National Cancer Institute (NCI) status lines. However, the NCI Carcinogenesis Testing Program has been absorbed by NTP, and the status lines have been reformatted accordingly. The following five different citations are used to reflect the current test status of the compound: selected for test, undergoing test, test results incomplete, test completed, or report available. These citations are updated as each bioassay progresses. Note that selection of a chemical for bioassay does not necessarily imply that it is a carcinogen, and that a compound originally scheduled for bioassay may be withdrawn from the NTP program before testing actually begins. This initial selection is cited but is deleted when the compound is removed from the test. It is therefore important that the reader monitor the NTP status lines for changes. When the final report is released, the report number and test results are listed, and, where applicable, specific toxic dose lines (see p. xx) are generated. Also, some substances may be selected by NTP for retest after the bioassay is completed and the final report issued. These duplicate studies are noted on a separate NTP status line. To obtain additional information about NTP, the Carcinogenesis Testing Program, or the status of a particular substance under test, contact the Technical Information Section, National Toxicology Program.

b. NIOSH status lines are included for those substances for which an analytical method(s) has been developed by NIOSH or for substances for which NIOSH current intelligence bulletins (CIB's) have been issued. The former status line includes a citation to the appropriate volume(s) and method number(s) in the "NIOSH Manual of Analytical Methods, Second Edition."

c. An EPA TSCA status entry indicates that the sub-

stance appears on the chemical inventory prepared by the Environmental Protection Agency in accordance with provisions of the Toxic Substances Control Act (TSCA). Substances reported in the inventory include those that are produced commercially in or imported into this country. The reader should note, however, that substances already regulated by EPA under FIFRA and by the Food and Drug Administration under the Food, Drug, and Cosmetic Act, as amended, are not included in the TSCA inventory. Similarly, alcohol, tobacco, and explosive substances are not regulated under TSCA. TSCA regulations should be consulted for an exact definition of reporting requirements. For additional information about TSCA, contact EPA, Office of Toxic Substances, Washington, D.C. 20402. Specific questions about the inventory can be directed to the EPA Office of Industry Assistance, telephone (800) 424-9065.

Disaster Hazard: When heated to decomp it emits very tox fumes of Br^- and F^-.

PERCHLORATES

Composition: combinations with the monovalent $^-ClO_4$ radical.

THR: Perchlorates are unstable materials, and are irr to the skin and mu mem of the body wherever they come in contact with it. Avoid skn contact with these materials.

Fire Hazard: Mod, by chemical reaction; powerful oxidizers. See also explosives, high.

Explosion Hazard: Mod, when shocked or exposed to heat or by chemical reaction. Perchlorates, when mixed with carbonaceous material, form explosive mixtures. They are considered a fire and explosive hazard when associated with carbonaceous materials or finely divided metals. This is also true of the presence of sulfur, powdered magnesium and aluminum. See explosives, high. React violently with benzene, CaH_2, charcoal, olefins, ethanol, SrH_2, S, H_2SO_4.

Disaster Hazard: Dangerous; shock will explode them; when heated they emit highly tox fumes of Cl^-; they can react with reducing materials.

To Fight Fire: Water or foam.

PERCHLORIC ACID

CAS RN: 7601903 NIOSH #: SC 7500000
mf: $ClHO_4$; mw: 100.46

Colorless, fuming, unstable liquid; mp: −112°; bp: 19° @ 11 mm; d: 1.768 @ 22°.

SYN: PERCHLORIC ACID (DOT)

TOXICITY DATA:	3-2	CODEN:
orl-rat LD50:1100 mg/kg		GTPZAB 17(8),33,73
scu-mus LD50:250 mg/kg		GTPZAB 17(8),33,73
orl-dog LD50:400 mg/kg		GTPZAB 17(8),33,73

DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76. Reported in EPA TSCA Inventory, 1980.

THR: VERY irr to skn, eyes and mu mem. HIGH via oral and inhal routes. See also perchlorates.

Fire Hazard: See perchlorates.

Explosion Hazard: See perchlorates. React violently with acetic acid, (acetic acid + acetic anhydride), acetic anhydride, alcohols, (aniline + HCHO), Sb compounds, Bi, cellulose, charcoal, dibutyl sulfoxide, ethyl ether, dimethyl sulfoxide, F_2, (PbO + glycerine), glycolethers, glycols, HI, HCl, H_2, P_2O_5, hypophosphites, ketones, CH_3OH, NI_3, nitrosophenol, paper, (P_2O_5 + $CHCl_3$), NaI, steel, H_2SO_4, SO_3, wood. The anhydrous form can explode spont.

Also oleic acid, Fe sulfate, Tl acetate, ethylbenzene, HNO_3, nitrogenous epoxides, phosphine, pyridine, sodium phosphinate, trichloroethylene, P_2Zn_3, dehydrating agents, o-periodic acid, azo pigments, CCl_4, 2-methyl cyclohexanone, 1,3-bis(di-n-cyclopentadienyl iron)-2-propen-1-one, bis-1,2-diaminopropane-cis-dichlorochromium (III) perchlorate. carbon.

Disaster Hazard: See perchlorates.

PERCHLORIC ACID, AMMONIUM SALT

CAS RN: 7790989 NIOSH #: SC 7520000
mf: $ClO_4 \cdot H_4N$; mw: 117.50

White crystals. mp: decomp, d: 1.95.

SYN: AMMONIUM PERCHLORATE (DOT)

TOXICITY DATA:	2	CODEN:
par-rat LDLo:3500 mg/kg		RPTOAN 32,159,69
par-mus LDLo:2 gm/kg		RPTOAN 32,159,69
par-rbt LDLo:750 mg/kg		RPTOAN 32,159,69

DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76 Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FERREAC 45,13646,80.

THR: MOD par. A powerful oxidizer.

Fire Hazard: MOD, when exposed to heat or flame or by spont chemical reaction with reducing materials. A very powerful oxidizer. Ignites violently with combustibles.

Explosion Hazard: Severe, decomp @ 130° and explodes @ 380°. When contaminated by powdered carbon, ferrocene, S, organic matter, powdered metals it becomes impact sensitive. See also perchlorates.

Disaster Hazard: See perchlorates and explosives, high

PERCHLORIC ACID, BARIUM SALT · $3H_2O$

CAS RN: 13465957 NIOSH #: SC 7550000
mf: $Cl_2O_8 \cdot Ba \cdot 3H_2O$; mw: 390.4

Colorless crystals; mp: decomp @ 400°; d: 2.74.

SYN: BARIUM PERCHLORATE

TOXICITY DATA:	3	CODEN:

DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76 Reported in EPA TSCA Inventory, 1980.

THR: An unstable material. See also perchlorates and barium compounds. When refluxed with an alcohol a highly explosive product is formed.

Disaster Hazard: When heated to decomp it emits tox fumes of Cl^-.

PERCHLORIC ACID, MAGNESIUM SALT

CAS RN: 10034818 NIOSH #: SC 8925000
mf: $Cl_2O_8 \cdot Mg$; mw: 223.21

White, hygroscopic crystals. mp: decomp @ 251°, d: 2.60 @ 25°.

SYNS:
ANHYDRONE
DEHYDRITE
MAGNESIUM PERCHLORATE
PERCHLORATE DE MAGNESIUM (FRENCH)

TOXICITY DATA:	2	CODEN:
ipr-mus LD50:1500 mg/kg		JAFCAU 14,512,66

DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76 Reported in EPA TSCA Inventory, 1980.

THR: MOD via ipr route. See also magnesium compounds and perchlorates.

Fire Hazard: See perchlorates.

Explosion Hazard: See perchlorates. Avoid contact with mineral acids, ammonia, butyl fluorides, P, dimethyl sulfoxide, ethylene oxide, hydrocarbons, organic matter, trimethyl phosphite.
Disaster Hazard: See perchlorates.

PERCHLORIC ACID, NICKEL(II) SALT, compound with OCTAMETHYL PYROPHOSPHORAMIDE

CAS RN: 2638852 NIOSH #: QS 0642500
mf: $C_{24}H_{72}N_{12}NiO_9P_6 \cdot 2ClO_4$; mw: 1116.51

SYN: TRIS(OCTAMETHYLPYROPHOSPHORAMIDE) NICKEL(2+), DIPERCHLORATE

TOXICITY DATA: 3 CODEN:
ipr-mus LD50:15 mg/kg JAFCAU 14,512,66

Occupational Exposure to Inorganic Nickel recm std: Air: TWA 15 ug(Ni)/m3 NTIS**.
THR: HIGH ipr. See also perchlorates and nickel compounds.
Disaster Hazard: When heated to decomp it emits very tox fumes of NO_x, PO_x and Cl^-.

PERCHLORIC ACID, POTASSIUM SALT (1:1)

CAS RN: 7778747 NIOSH #: SC 9700000
mf: $ClO_4 \cdot K$; mw: 138.55

Colorless crystals or white crystalline powder. mp: 610° ± 10°, d: 2.52 @ 10°.

SYNS:
POTASSIUM HYPERCHLORIDE
POTASSIUM PERCHLORATE

TOXICITY DATA: 3 CODEN:
DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76. Reported in EPA TSCA Inventory, 1980.
THR: Powerful oxidizer. HIGH irr to skn, eyes and mu mem. Has been implicated in aplastic anemia. Violent reaction with (Al + Mg), charcoal, F_2, Mg, (Ni + Ti), reducing agents, S. Irr to skn and mu mem. Absorption can cause methemoglobinemia and kidney injury. Do not store close to flammable matter.
Disaster Hazard: When heated to decomp it emits tox fumes of Cl^- and K_2O.

PERCHLORIC ACID, SODIUM SALT

CAS RN: 7601890 NIOSH #: SC 9800000
mf: $ClO_4 \cdot Na$; mw: 122.44

Colorless deliquescent crystals. mp: 482° (decomp).

SYNS:
NATRIUMPERCHLORAAT (DUTCH)
NATRIUMPERCHLORAT (GERMAN)
PERCHLORATE DE SODIUM (FRENCH)
SODIO (PERCLORATO DI) (ITALIAN)
SODIUM PERCHLORATE
SODIUM PERCHLORATE (DOT)

TOXICITY DATA: 2 CODEN:
orl-rat LD50:2100 mg/kg GTPZAB 17(8),33,73
ipr-mus LD50:551 mg/kg COREAF 257,791,63
DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76. Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FERREAC 45,13646,80.
THR: MOD ipr. See perchlorates. Forms explosive with NH_4NO_3, CaH_2, charcoal, Mg, reducing agents, SrH_2.
Disaster Hazard: When heated to decomp it emits tox fumes of Cl^- and Na_2O.

PERCHLOROBUTADIENE

CAS RN: 87683 NIOSH #: EJ 0700000
mf: C_4Cl_6; mw: 260.74

Autoign. temp.: 1130°F, vap. d: 8.99.

SYNS:
HEXACHLOR-1,3-BUTADIEN (CZECH)
HEXACHLORBUTADIENE
1,1,2,3,4,4-HEXACHLORO-1,3-BUTADIENE

TOXICITY DATA: 3 CODEN:
orl-rat TDLo:45 mg/kg (13W male/13W pre-3W post) TXAPA9 42,387,77
orl-rat TDLo:4 gm/kg (13W male/13W pre-3W post) TXAPA9 42,387,77
ipr-rat TDLo:150 mg/kg (1-15D preg) EPASR* 8EHQ-0381-0386
scu-rat TDLo:20 mg/kg (1D pre) GISAAA 31,33,66
skn-rbt 810 mg/24H MOD JETOAS 9,171,76
eye-rbt 162 mg MLD JETOAS 9,171,76
ipr-mus TDLo:160 mg/kg/(1-15D preg):TER APTOD9 18,A35,79
orl-rat TDLo:15 gm/kg/2Y-C:CAR AIHAAP 38(1),589,77
orl-rat LD50:90 mg/kg HYSAAV 31,18,66
ipr-rat LD50:175 mg/kg JETOAS 8(3),180,75
orl-mus LD50:110 mg/kg SCCUR* -,5,61
ihl-mus LCLo:235 ppm/4H SCCUR* -,5,61
ipr-mus LD50:76 mg/kg JETOAS 7(4),247,74
skn-rbt LD50:1211 mg/kg APTOA6 43,346,78
orl-gpg LD50:90 mg/kg GISAAA 28,9,63
orl-ham LD50:960 mg/kg TXAPA9 48,A192,79
unk-mam LD50:200 mg/kg 30ZDA9 -,40,71

TLV: Carcinogenic Determination: Animal Positive IARC** 20,179,79. Threshold Limit Value Air: 0.02 ppm (skin) DTLVS* 4,211,80. "NIOSH Manual of Analytical Methods" VOL 5 307#. Reported in EPA TSCA Inventory, 1980. EPA TSCA 8(a) Preliminary Assessment Information Proposed Rule FERREAC 45,13646,80.
THR: An exper CARC, TER. An MLD skn, eye irr in rbt. HIGH oral and inhal.
Fire Hazard: Low.
To Fight Fire: Dry chemical, CO_2, alcohol foam, water spray, fog, mist.
Disaster Hazard: When heated to decomp it emits very tox fumes of Cl^-.

PERCHLORO-2-CYCLOBUTENE-1-ONE

CAS RN: 3200962 NIOSH #: GU 1850000
mf: C_4Cl_4O; mw: 205.84

SYN: 2,3,4,5-TETRACHLORO-2-CYCLOBUTEN-1-ONE

TOXICITY DATA: 3 CODEN:
scu-mus TDLo:280 mg/kg/70W-I:ETA JNCIAM 46,143,71

Disaster Hazard: When heated to decomp it emits very tox fumes of NH_3 and NO_x.

AMMONIUM OXALATE

mf: $(NH_4)_2C_2O_4 \cdot H_2O$; mw: 142.12

Colorless crystals. mp: decomp; d: 1.50; slightly sol in water.

THR: See oxalates. A poison.
Incomp: Can react violently with (NaOCl + ammonium acetate).
Disaster Hazard: When heated to decomp it can emit tox fumes of NH_3 and NO_x.

AMMONIUM PENTA PEROXODICHROMATE

mf: $Cr_2H_8N_2O_{12}$; mw: 332.2

THR: An unstable compound. Detonation can be initiated by heat, friction or impact. See also chromium compounds. Expl @ 50°.
Disaster Hazard: When heated to decomp it emits tox fumes of NO_x.

AMMONIUM PERCHLORATE

mf: NH_4ClO_4; mw: 117.50

White crystals. mp: decomp; d: 1.95.

THR: See perchlorates. Easily ignited by friction. Can decomp or explode when mixed with sugar, charcoal, or on contact with hot Cu pipes.
Explosion Hazard: Severe, decomp @ 130°. Can be ignited by sparks. When mixed with C can explode above 240°. When contaminated by powdered carbon, ferrocene, S, organic matter, powdered metals it becomes impact sensitive. See also perchlorates.
Incomp: Can be sensitized by nitryl perchlorate, KIO_4, $KMnO_4$, as cocrystallized impurities, metals. When contaminated by powdered carbon, ferrocene, S, organic matter, powdered metals it becomes impact sensitive. See also perchlorates.
Disaster Hazard: See perchlorates and explosives, high. When heated to decomp it emits tox fumes of NH_3, Cl^- and NO_x.
For further information see Vol. 2, No. 3 of *DPIM Report.*

AMMONIUM PERCHLORYL AMIDE:

mf: $H_5N_2O_3Cl$; mw: 116.6

mp: 80°

THR: Very dangerous. Is shock sensitive. May detonate @ 80°.
Disaster Hazard: When heated to decomp it emits very tox fumes of NH_3, NO_x and Cl^-.

AMMONIUM-m-PERIODATE

mf: NH_4IO_4; mw: 209

Colorless crystals. mp: explodes; d: 3.056.

THR: Can become very unstable and explode on contact. See also iodates. An oxidizer. See also iodides.
Disaster Hazard: When heated to decomp it can emit tox fumes of NH_3, NO_x and I^-.
Incomp: Heat, impact, and touch as from a scoop or abrasive impact.

AMMONIUMPERMANGANATE

mf: NH_4MnO_4; mw: 137.0

Crystalline solid. mp: explodes; d: 2.208 @ 10°.

THR: See also manganese compounds.
Fire Hazard: Mod by chemical reaction with reducing agents. A powerful oxidizer.
Explosion Hazard: High when shocked or warmed to 60°. Can be exploded by percussion.
Disaster Hazard: Mod dangerous; shock and heat will explode it; when heated to decomp it emits tox fumes of NO_x and NH_3.
Incomp: Reducing material, friction (explodes @ 60°).

AMMONIUM PEROXO BORATE

mf: $BH_4NO_3 \cdot 1/2H_2O$; mw: 85.86

White crystals. mp: decomp; slightly sol in water.

THR: See also boron compounds. Potentially shock-sensitive or explosive via heat, friction, impact.
Disaster Hazard: When heated to decomp it emits tox fumes of NO_x and NH_3.
Incomp: Explodes in vacuo.

AMMONIUM PEROXO DISULFATE

mf: $H_8N_2O_8S_2$; mw: 228.2

THR: See also sulfates. An unstable compound. Detonated via heat, friction or impact. A powerful oxidizer.
Incomp: Al, H_2O, powdered metal, Ag salts, Fe, Na_2O_2, zinc, NH_3.
Disaster Hazard: When heated to decomp it emits very tox fumes of SO_x, NO_x and NH_3.

AMMONIUMPEROXY CHROMATE

mf: $(NH_4)_3CrO_2$; mw: 234.1

Red-brown crystals. mp: decomp @ 40°, bp: explodes @ 50°.

THR: See also chromium compounds.
Fire Hazard: Mod, by chemical reaction with reducing agents. A powerful oxidizer.
Explosion Hazard: Mod, when heated.
Disaster Hazard: Mod dangerous; when heated to decomp it emits tox fumes of NO_x, NH_3 and may explode.

AMMONIUM PERSULFATE

CAS RN: 7727540 NIOSH #: SE 0350000
mf: $O_8S_2 \cdot 2H_4N$; mw: 228.22

White crystals. mp: decomp @ 120°, d: 1.982.

SYNS:
AMMONIUM PEROXYDISULFATE PERSULFATE D'AMMONIUM (FRENCH)

POTASSIUM PERCHLORATE

CAS RN: 7778-74-7 NIOSH #: SC9700000
mf: $ClO_4 \cdot K$; mw: 138.55

Colorless crystals or white powder. Decomp @ 400° and with organic matter. d: 2.52 mp: 610° ± 10°. Insol in alc.

SYNS:
PERIODIN
POTASSIUM HYPERCHLORIDE

REPRODUCTIVE EFFECTS
DATA: 3 CODEN:
orl-rbt TDLo:2100 mg/kg (1-21D preg) AMASA4 23,223,67

DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76. Reported in EPA TACA Inventory, 1980.
THR: An exper TER. Powerful oxidizer. HIGH irr to skn, eyes and mu mem. Has been implicated in aplastic anemia. Absorption can cause methemogloglobinemia and kidney injury.
Disaster Hazard: When heated to decomp it emits very tox fumes of K_2O and Cl^-.
Incomp: (Al + Mg), charcoal, F_2, Mg, (Ni + Ti), reducing agents, S.

POTASSIUM PERIODATE

mf: IKO_4; mw: 230.01

Colorless cryst.
Mp: 582°; (decomp). $-O_2$ @ 300°; d: 3.618 @ 15°.

THR: No tox data. See also iodates. Powerful oxidizer, irr to skn, eyes and mu mem. See iodates.
Disaster Hazard: When heated to decomp it emits very tox fumes of K_2O and I^-.
Fire Hazard: An oxidizing agent and mod fire hazard.
Incomp: Ammonium perchlorate.

POTASSIUM PERMANGANATE

CAS RN: 7722647 NIOSH #: SD 6475000
mf: $MnO_4 \cdot K$; mw: 158.04

Dark purple crystals with a blue metallic sheen, sweetish astringent taste. mp: decomp @ <240°, d: 2.703.

SYNS:
CHAMELEON MINERAL
C.I. 77755
CONDY'S CRYSTALS
KALIUMPERMANGANAAT (DUTCH)
KALIUMPERMANGANAT (GERMAN)
PERMANGANATE DE POTASSIUM (FRENCH)
PERMANGANATE OF POTASH
POTASSIO (PERMANGANATO DI) (ITALIAN)
POTASSIUM (PERMANGANATE DE) (FRENCH)
POTASSIUM PERMANGANATE (DOT)

TOXICITY DATA: 3-2 CODEN:
dnr-bcs 17 mg/L WATRAG 14,1613,80
cyt-mus:mmr 1 mmol/L/48H MUREAV 67,221,79
orl-wmn TDLo:2400 ug/kg/D:GIT AIPTAK 44,446,33
orl-rat LD50:1090 mg/kg AIHAAP 30,470,69
scu-mus LD50:500 mg/kg 27ZWAY 3.2,1346,-
orl-rbt LDLo:700 mg/kg AIPTAK 14,289,05
ivn-rbt LDLo:70 mg/kg EQSSDX 1,1,75

Aquatic Toxicity Rating: TLm96:100-1 ppm WQCHM* 4,-,74. DOT: Oxidizer, Label: Oxidizer FEREAC 41,57018,76. Reported in EPA TSCA Inventory, 1980
THR: MUT data. A hmn GIT. HIGH ivn; MOD orl scu. A strong irr because of oxidizing properties. See also manganese compounds.
Fire Hazard: Mod, by chemical reaction. A powerful oxidizing agent. Spont flam on contact with glycerine, ethylene glycol, Al_4C_3, Sb, As, dimethyl sulfoxide, H_2O_2, H_2S_3, NH_2OH, organic matter, P, polypropylene, S, H_2SO_4, (H_2SO_4 + organic matter), (H_2SO_4 + KCl), Ti, wood, HCl, NH_4ClO_4, NH_3, NH_4NO_3.
Explosion Hazard: Handle with care. Explosions may occur in contact with organic or readily oxidizable materials, either when dry or in solution.
Disaster Hazard: Dangerous; keep away from combustible materials.

POTASSIUM PEROXIDE

CAS RN: 17014710 NIOSH #: TT 4450000
mf: KO_2; mw: 71.1

Yellow, amorphous mass (white crystals). mp: 490°.

TOXICITY DATA:
DOT:-oxidizer, Label: oxidizer FEREAC 41,57018,76. Reported in EPA TSCA Inventory, 1980.
THR: See peroxides, inorganic.
Fire Hazard: Dangerous, by spont chemical reaction. It is a very powerful oxidizer. Fires of this material should be handled like sodium peroxide fires.
Explosion Hazard: Mod, by spont chemical reaction. Also violent reactions with air, Sb, As, O_2, K, water.
Disaster Hazard: Dangerous; will react with water or steam to produce heat; on contact with reducing material, can react vigorously; on contact with acid or acid fumes, it can emit tox fumes.
Imcomp: Carbon; diselenium dichloride; ethanol; hydrocarbons; metals.

POTASSIUM PEROXYFERRATE

mf: FeK_2O_5; mw: 214.06

THR: No tox data.
Disaster Hazard: When heated to decomp it emits tox fumes of K_2O.
Incomp: Self-explodes. Violent reaction with non-metals or sulfuric acid.

POTASSIUM PEROXYSULFATE

NIOSH #: SE 1000000

mf: $HO_5S \cdot K$; mw: 152.17

SYN: POTASSIUM MONOPERSULFATE

TOXICITY DATA: 2 CODEN:
skn-gpg 25% SEV 27ZTAP 3,118,69

Toxicology Review: 27ZTAP 3,118,69.
THR: A skn irr. Very tox and irr to skn, eyes and mu mem.